APPENDIX L

ESSENTIAL FISH HABITAT (PHYSICAL HABITAT)

JACKSONVILLE HARBOR NAVIGATION (DEEPENING) STUDY

DUVAL COUNTY, FLORIDA

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ESSENTIAL FISH HABITAT ASSESSMENT

JACKSONVILLE HARBOR
NAVIGATION STUDY
DUVAL COUNTY, FL

Final Report

January 2011

Prepared for:

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U.S. Army Corps of Engineers
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1.0 INTRODUCTION

Dial Cordy and Associates Inc. (DC&A) was contracted by the United States Army Corps of Engineers (USACE) to prepare an Essential Fish Habitat Assessment (EFH) for the Jacksonville Harbor Navigation Study. In support of this EFH assessment, a side-scan sonar survey and a benthic habitat sampling were also performed for the proposed nearshore and beach placement areas. The result of this effort is summarized in Appendix A.

The Jacksonville Port Authority (JPA) has requested the USACE study the feasibility of further deepening the federal system of channels within the Jacksonville Harbor (Figure 1). The objective of the study includes evaluation of the potential navigation benefits derived from deepening the main shipping channel at one-foot increments from the 40-foot existing depth to depths of up to 50 feet from the St. Johns River entrance channel to River Mile 20. The proposed project would include deepening the West Blount Island Channel at one-foot increments, from an existing 38-foot depth to a 50-foot depth, widening portions of the channel and creating turning basins. The excavation work would be performed utilizing backhoes and a combination of hopper, cutterhead, and clamshell dredges. If required, explosives may be utilized for some rock removal. The project area includes a total area of 354.871 acres of mostly sandy habitat (Table 1). Benthic substrates and/or habitats impacted by excavation for the project would include sand, rock, rock outcrop, and open water habitats (Figures 2a and 2b). Some rock habitat is located in Broward Point Turn Widening, Trout River Reach Widening, and Training Wall Range Widening (WAR 2009).

Up to 43,000,000 cubic yards (CY) of dredged material, consisting of rock and unconsolidated substrate, may be placed at the following existing or proposed spoil disposal locations (USACE 1998).

- Existing Jacksonville Ocean Dredged Material Disposal Site (ODMDS)
- Proposed Expanded Jacksonville ODMDS
- Proposed Nearshore Placement Area and Existing Beach Placement Area
- Existing Florida Inland Navigation District (FIND) Dredged Material Management Area (DMMA) DU-6
- Proposed FIND DMMA DU-7
- Existing Buck Island Disposal Site
- Bartram Island Disposal Site (existing cells)
- Proposed Bartram Island Disposal Site Expansion Area
- Proposed St. Johns River Power Park Tract DMMA
- Proposed Polly Town Tract DMMA
- Proposed Imeson Industrial Park, Barnett Bank Trust, Co., Imeson-Cariss Tracts DMMA
- Proposed Navy Fuel Depot Tract DMMA

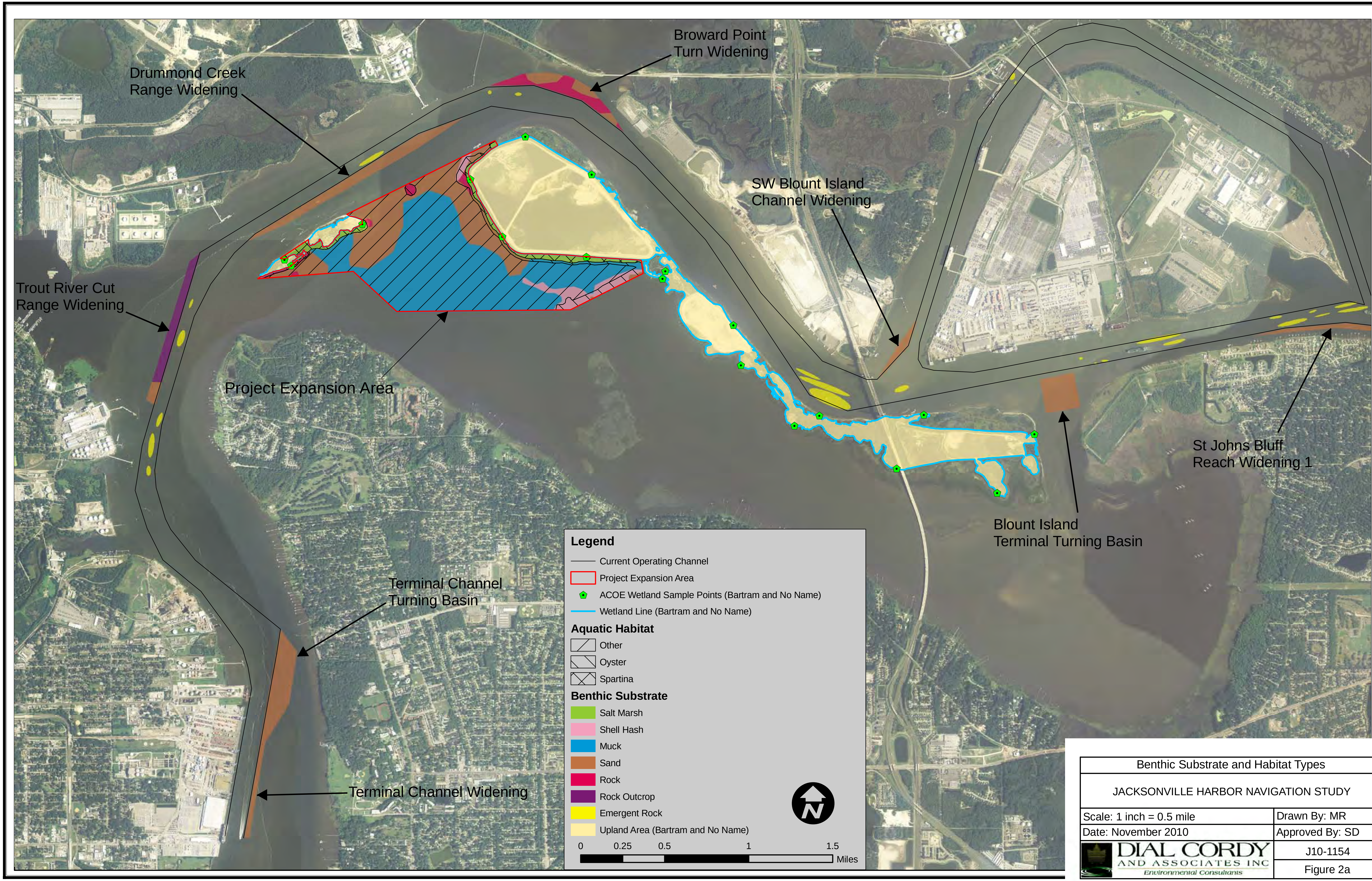
It is anticipated that the bulk of dredged material would be placed in the Jacksonville ODMDS. This EFH does not include direct and/or indirect effects associated with disposal in the ODMDS. Information on the proposal expansion of the ODMDS will be available in a forthcoming EIS document being prepared by U.S. Environmental Protection Agency (EPA) in cooperation with the USACE.

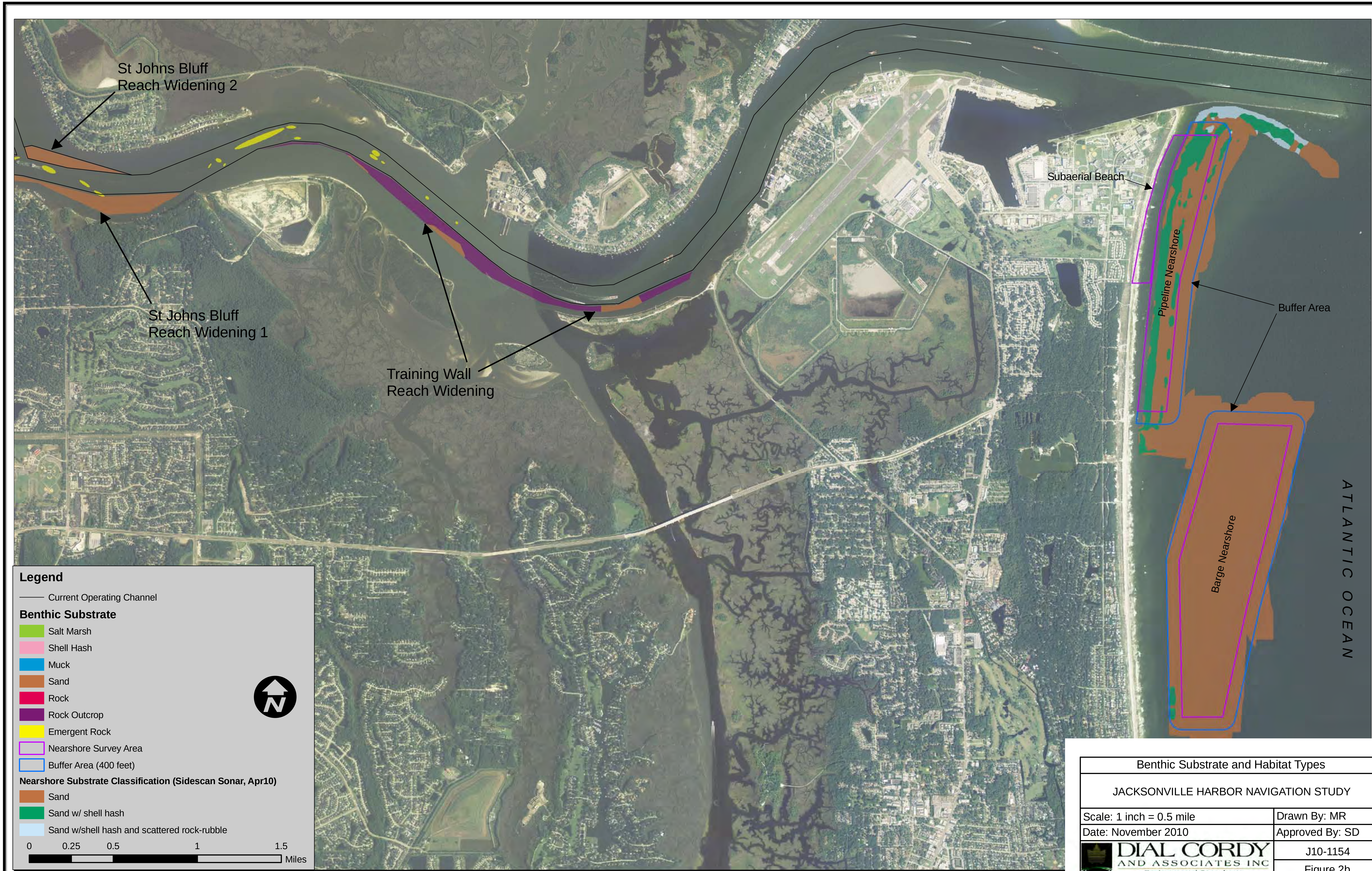
Placement of material in the proposed nearshore beach area would result in the impact of 651 acres of sand and open water habitat (Figure 1).

Table 1. Benthic substrate classification and area for channel widening elements (WAR 2009).

Project Name	Bottom Type	Area (acres)	Total Area (acres)
Blount Island Terminal Turning Basin	Sand	27.233	27.233
Broward Pt Turn Widening	Rock Outcrop	23.318	37.911
	Sand	14.593	
Drummond Creek Range Widening	Sand	45.693	45.693
St. Johns Bluff Reach Widening 1	Sand	49.522	49.522
St. Johns Bluff Reach Widening 2	Sand	19.439	19.439
Terminal Channel Turning Basin	Sand	43.465	43.465
Training Wall Reach Widening	Rock Outcrop	72.831	84.893
	Sand	12.061	
Trout River Cut Range Widening	Rock Outcrop	24.871	29.286
	Sand	4.415	
SW Blount Island Channel Widening	Sand	7.400	7.400
Terminal Channel Widening	Sand	10.030	10.030
Total Area for All Channel Widening Elements			354.871

Jacksonville Harbor Project Study Elements	
JACKSONVILLE HARBOR NAVIGATION STUDY	
Scale: 1 inch = 1 mile	Drawn By: MR
Date: November 2010	Approved By: SD
DIAL CORDY AND ASSOCIATES INC Environmental Consultants	J10-1154
	Figure 1


Broward Point
Turn Widening
Drummond Creek
Range Widening
SW Blount Island
Channel Widening
Trout River Cut
Range Widening
Project Expansion Area
St Johns Bluff
Reach Widening 1
Blount Island
Terminal Turning Basin
Terminal Channel
Turning Basin
Terminal Channel Widening
Legend
Current Operating Channel
Project Expansion Area
ACOE Wetland Sample Points (Bartram and No Name)
Wetland Line (Bartram and No Name)
Aquatic Habitat
Other
Oyster
Spartina
Benthic Substrate
Salt Marsh
Shell Hash
Muck
Sand
Rock
Rock Outcrop
Emergent Rock
Upland Area (Bartram and No Name)
0 0.25 0.5 1 1.5
Miles
N
Benthic Substrate and Habitat Types
JACKSONVILLE HARBOR NAVIGATION STUDY
Scale: 1 inch = 0.5 mile
Drawn By: MR
Date: November 2010
Approved By: SD
DIAL CORDY AND ASSOCIATES INC
Environmental Consultants
J10-1154
Figure 2a



Benthic Substrate and Habitat Types

JACKSONVILLE HARBOR NAVIGATION STUDY

Scale: 1 inch = 0.5 mile	Drawn By: MR
Date: November 2010	Approved By: SD
	J10-1154
	Figure 2b

2.0 ESSENTIAL FISH HABITAT DESIGNATION

In accordance with the Magnuson-Stevens Fishery Conservation and Management Act of 1976 and the 1996 Sustainable Fisheries Act, an EFH assessment is necessary for this project. An EFH is defined as "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity." *Waters* include aquatic areas and their associated physical, chemical, and biological properties that are used by fishes and may include areas historically used by fishes. *Substrate* includes sediment, hardbottom, structures underlying the waters, and any associated biological communities. *Necessary* means the habitat required to support a sustainable fishery and the managed species' contribution to a healthy ecosystem. *Spawning, breeding, feeding, or growth to maturity* covers all habitat types used by a species throughout its life cycle. Only species managed under a federal fishery management plan (FMP) are covered (50 C.F.R. 600). The act requires federal agencies to consult on activities that may adversely influence EFH designated in the FMPs. The activities may have direct (e.g., physical disruption) or indirect (e.g., loss of prey species) effects on EFH and may be site-specific or habitat-wide. The adverse result(s) must be evaluated individually and cumulatively. EFH must be identified and described for each life stage and for all species in the fishery management unit (FMU), as well as the physical, biological, and chemical characteristics of EFH, and, if known, how these characteristics influence the use of EFH by each species and life stage [South Atlantic Fishery Management Council (SAFMC) 1998].

2.1 Assessment

The most obvious direct impact of the proposed action on managed species in all habitats is the potential for mortality and/or injury of individuals through the dredging and/or blasting processes. Species in any and all of the project area's habitats are susceptible. Fishes and invertebrates are at risk at any life-history stage; eggs, larvae, juveniles, and even adults may be inadvertently killed, disabled, or undergo physiological stress, which may adversely affect behavior or health. Forms that are less motile, such as juvenile shrimp, are particularly vulnerable (they would be entrained into the dredge apparatus, or otherwise directly removed from their habitat).

Blasting will also have a direct impact on managed fish species residing in/migrating through the Jacksonville Harbor and associated waterways. Previous studies (USACE 1996; O' Keefe 1984; Keevin and Hempen 1997; Young 1991) have addressed the impacts of blasting on fishes. Fishes with air bladders are particularly more susceptible to the effects of blasting than aquatic taxa without air bladders (e.g. shrimp, crabs, etc), which are more resistant to the impacts of blasting (Keevin and Hempen 1997). Small fish are the most likely to be impacted.

Although dredge operations are likely to directly impact individuals of managed species in observable lethal and sublethal ways, dredging and blasting may have more subtle effects. These subtle effects act on individuals, but may be perceived only at the population level. For example, dredging/blasting activities, particularly in linear corridors may interfere with migration patterns of species that require utilization of both inshore and offshore habitats through ontogeny. This is a particular concern for species that travel along shorelines and bulkheads. Therefore dredging berths and littoral zone habitats is anticipated to have greater effects. These impacts may result in displacement of individuals or disjuncture in the life-cycles of managed species.

Impacts to the water column EFH can have widespread effects on marine and estuarine species. The water column is a habitat used for foraging, spawning, and migration by both managed species and organisms consumed by managed species. Water quality concerns are of particular importance in the maintenance of this important habitat. Dredging in substrates comprising coarser materials and rock, minimal water quality impacts are expected. However, where silt and/or silty sand are to be dredged, water quality impacts are expected to be significant and take several weeks and/or months after cessation of dredging activities to return to background levels. Re-suspended materials will interfere with the diversity and concentration of phytoplankton and zooplankton, and therefore affect foraging success and patterns of schooling fishes and other grazers that comprise prey for managed species. Recent efforts to quantify areal impacts of dredging incorporate only the waters directly above dredged substrates. However, due to the physical properties of water and the complex hydraulics operating within the harbor and channels, these efforts greatly underestimate the extent of negative effects of dredging.

The temporary or permanent loss of EFH, such as submerged aquatic vegetation (SAV) beds, inshore softbottom, and hardgrounds result in the loss of substrates used by managed species for spawning, nursery, foraging, and migratory/temporary habitats. Within the proposed project, area habitats include muck (60.3%), sand (27%), shell hash (5.5%), rock (1.6%), and salt marsh (5.5%). No SAV was documented in the expansion areas during previous assessments [Water and Air Research Inc. (WAR) 2009]. Oyster reef and salt marsh habitat may be impacted within the proposed expansion areas (WAR 2009). Impacts to these habitats would be mitigated for and mitigation requirements for this project have been pre-determined to be 156 acres (WAR 2009). The most critical losses of EFH would be those areas additionally designated as Habitat Areas of Particular Concern (HAPC). Coastal inlets are HAPC for shrimps, red drum, and grouper. Inlets are important for these species that prefer estuarine, inshore habitats such as salt marsh, SAV beds, and mudflats. Placement of material along the beach and in nearshore habitats may also impact HAPC due to its proximity to the inlet.

Direct and indirect impacts to populations of managed species will occur due to dredging softbottom habitats, including those that lack SAV. Dredging will remove benthic organisms used as prey by managed species and, as a result, may temporarily impact certain species, such as red drum, that forage largely on such taxa. Dredged habitats are anticipated to recover, in terms of benthic biodiversity and population density, within two years (Culter and Mahadevan 1982; Saloman et. al 1982).

The aquatic communities associated with these different bottom types and the water column have been identified as EFH in accordance with the amendment to the Fishery Management Plans of the South Atlantic Region (SAFMC 1998). Direct and indirect impacts associated with widening and deepening of the harbor are unavoidable. However, the temporary disruption of the water column, sand bottom, and hardbottom (rock and/or rock outcrop) areas that may provide habitat or contribute to aquatic food chains will be minimized by implementing strict management practices to reduce turbidity.

2.2 Managed Species

Species within the study area are managed with guidance from the Mid-Atlantic Fisheries Management Council (MAFMC), SAFMC, and the National Marine Fisheries Services (NMFS) (SAFMC 1998; NMFS 2006; NMFS 2008). The species addressed in this section consist of fishes and invertebrates of both recreational and commercial importance that are managed under the Magnuson-Stevens Fishery Conservation and Management Act (PL94-265). These species include the commercially or recreationally important stocks such as Penaeid shrimp, as well as species included in the Snapper-Grouper Complex, Coastal Migratory Pelagics, and Highly Migratory Atlantic Species (NMFS 2010a).

Fishery Management Councils have also designated areas as HAPC based on habitat level considerations rather than the life stages of particular species. These HAPC include habitats that have an important ecological function; habitats that are sensitive to human degradation; rarity of the habitat; and whether the habitat will be stressed by development (NMFS 2008).

The St. Johns River and its tributaries within the proposed project area have been designated HAPC by the MAFMC and the SAFMC. Habitats that are of particular concern include the Summer Flounder, Red Drum, Coastal Migratory Pelagics, Snapper-Grouper Complex, and Penaeid Shrimp (SAFMC 1998; NMFS 2010a). A summary of all managed species is included in Table 2. Life history summaries and HAPC designation descriptions are included in the following sections.

Table 2. Managed species identified by the NMFS that are known to occur in St. Johns River vicinity, Duval County, Florida.

Species	Taxa	HAPC	Presence
MAFMC			
Summer Flounder	*Paralichthys denatatus*	Yes	Year Round
Bluefish	*Pomatomus saltatrix*	No	Year Round
SAFMC			
Coastal Migratory Pelagics	5 species	No	Summer
Snapper-Grouper Complex	73 species	Yes	Summer
Penaeid Shrimp	3 species	Yes	Summer/Winter
Highly Migratory Atlantic Species			
Atlantic Sharpnose Shark	*Rhizoprionodon terraenvae*	No	Year Round
Blacktip Shark	*Carcharinus limbatus*	No	Summer
Blacknose Shark	*Carcharhinus acronotus*	No	Summer
Bonnethead Shark	*Sphyrna tiburo*	No	Year Round
Bull Shark	*Carcharhinus leucas*	No	Unknown/Rare
Dusky Shark	*Carcharhinus obscures*	No	Unknown/Rare
Finetooth Shark	*Carcharhinus isodon*	No	Unknown/Rare
Lemon Shark	*Negaprion brevirostris*	No	Unknown/Rare
Nurse Shark	*Gingloymostoma cirratum*	No	Unknown/Rare
Sandbar Shark	*Carcharhinus plumbeus*	Yes	Unknown/Rare
Sand Tiger Shark	*Odontaspis taurus*	No	Unknown /Rare
Scalloped Hammerhead	*Sphyrna lewini*	No	Seasonal Migration

Species	Taxa	HAPC	Presence
Spinner Shark	*Carcharhinus brevipinna*	No	Seasonal Migration
Tiger Shark	*Galeocerdo cuvieri*	No	Unknown/Rare

2.2.1 Penaeid Shrimp

2.2.1.1 Life Histories

2.2.1.1.1 Brown Shrimp

Brown shrimp larvae occur offshore and migrate from offshore as post-larvae from January through November with peak migration from February through April. Post-larvae move into the estuaries primarily at night on incoming tides. Once in the estuaries, post-larvae seek out the soft silty/muddy substrate common to both vegetated and non-vegetated, shallow estuarine environments. This environment yields an abundance of detritus, algae, and microorganisms that comprise their diet at this developmental stage. Post-larvae have been collected in salinities ranging from zero to 69 parts per thousand (ppt) with maximum growth reported between 18° and 25°C, peaking at 32°C (Lassuy 1983). Maximum growth, survival, and efficiency of food utilization have been reported at 26°C (Lassuy 1983). The density of post-larvae and juveniles is highest among emergent marsh and submerged aquatic vegetation (Howe et al. 1999; Howe and Wallace 2000), followed by tidal creeks, inner marsh, shallow non-vegetated water, and oyster reefs. The diet of juveniles consists primarily of detritus, algae, polychaetes, amphipods, nematodes, ostracods, chironomid larvae, and mysids (Lassuy 1983). Although some of their potential prey will initially be lost during dredging activities, recovery will be rapid (Culter and Mahadevan 1982; Saloman et al. 1982) and they can forage in adjacent areas that have not been impacted as they emigrate offshore. Emigration of sub-adults from the shallow estuarine areas to deeper, open water takes place between May through August, with June and July reported as peak months. The stimulus behind emigration appears to be a combination of increased tidal height and water velocities associated with new and full moons. After exiting the estuaries, adults seek out deeper (18 m), offshore waters in search of silt, muddy sand, and sandy substrates. Adults reach maturity in offshore waters within the first year of life.

2.2.1.1.2 Pink Shrimp

Of the three penaeid shrimp species, pink shrimp is the most prevalent in Florida waters. Consequently, the pink shrimp fishery is the most economically important of all fisheries in Florida. Spawning of pink shrimp occurs in oceanic waters at depths of 4 to 48 m and possibly deeper (Bielsa et al. 1983) where adult females lay demersal eggs. Spawning takes place year round in some areas (e.g., Tortugas Shelf), but peak spawning activity appears to coincide with maximum bottom water temperatures (Bielsa et al. 1983). Recruitment of planktonic post-larvae into estuarine and coastal bay nursery areas occurs in the spring and late fall during flood tides. Post-larvae become benthic at approximately 10 mm Total Length (TL) and prefer areas with a soft sand or mud substrate mixture containing SAV (sea grasses and turtle grass) (Bielsa et al. 1983; Howe et al. 1999; Howe and Wallace 2000). Pink shrimp spend from 2 to 6 months in the nursery ground prior to emigration. During this time, there is a dietary shift from nauplii and microplankton to polychaetes, ostracods, caridean shrimps, nematodes, algae, diatoms, amphipods, mollusks, and mysids, for post-larvae and juveniles, respectively (Bielsa et al. 1983). Although some of their potential prey will initially be lost during dredging activities, recovery will be rapid (Culter and Mahadevan 1982; Saloman et al. 1982) and they can forage in adjacent areas that have not been impacted as they emigrate offshore. Emigration from the nursery grounds to offshore occurs year-round with a peak during the fall and a smaller peak during the spring. The greatest concentrations of adults have been reported between 9 and 44 m, although some have been found as deep as 110 m in Florida waters. Although detailed dietary studies concerning adults are limited, Williams (1955) reported foraminiferans, gastropod shells, squid, annelids, crustaceans, small fishes, plant material, and debris in the stomachs of adults collected in North Carolina estuaries.

2.2.1.1.3 White Shrimp

White shrimp spawn along the South Atlantic coast from March to November, with May and June reported as peak months along the offshore waters of northeast Florida. Spawning takes place in water ≥ 9 m deep and within 9 km from the shore where they prefer salinities of ≥ 27 ppt (Muncy 1984). The increase in bottom water temperature in the spring is thought to trigger spawning. After the demersal eggs hatch, the planktonic post-larvae live offshore for approximately 15 to 20 days. During the second post-larval stage, they enter Florida estuaries in April through early May by way of tidal currents and flood tides and become benthic. During this larval stage, the diet consists of zooplankton and phytoplankton. It has been documented that juvenile white shrimp tend to migrate further upstream than do juvenile pink or brown shrimp; as far as 210 km in northeast Florida (Pérez-Fartante 1969). Juveniles prefer shallow estuarine areas with a muddy substrate with loose peat and sandy mud and moderate salinity. Juvenile white shrimp are benthic omnivores (e.g., fecal pellets, detritus, chitin, bryozoans, sponges, corals, algae, annelids) and feed primarily at night. White shrimp usually become sexually mature at age one during the calendar year after they hatched. The emigration of sexually mature adults to offshore waters is influenced primarily by body size, age, and environmental conditions. Studies have shown that a decrease in water temperature in estuaries triggers emigration in the south Atlantic (Muncy 1984). The life span of white shrimp usually does not extend beyond one year.

2.2.1.2 Summary of Impacts to Penaeid Shrimp

As outlined by SAFMC (1998), EFH-HAPCs for penaeid shrimp includes coastal inlets and both state identified overwintering areas and nursery habitats.

The proposed project area includes sand bottom, rock, and water column that may be used by all three penaeid species. The proposed project would impact a relatively small area of the sand and rock bottoms, and the impacts would be minor. Direct and indirect impacts to juvenile shrimp within the proposed project areas during dredging and blasting is expected. Construction timing of the proposed project to correspond with times when penaeid shrimp are not migrating heavily through the area will also further reduce impacts. The proposed project will temporarily cause localized turbidity during construction; however, turbidity would be minimized using best management practices so that any impacts would be minor and temporary. Penaeid shrimp would be temporarily displaced, but would quickly return to the project area.

2.2.2 Bluefish

Bluefish are a migratory and pelagic species inhabiting most temperate coastal regions and are found along the entire east coast of the United States. Populations along the U.S. Atlantic Coast range from Maine to Florida with many wintering or spawning near the Mid-Atlantic Bight (Shepherd 2006). Bluefish can reach an age of 12 years and a size of over 100 cm standard length (SL). Adult populations head north from the Bight to winter while others migrate south to the Florida coast (NMFS 2006). By summer, bluefish move north into the Middle Atlantic Bight, although some medium size fish may remain off Florida (Shepherd 2006; Shepherd et al. 2006). A second spawning occurs in the offshore waters of the Mid-Atlantic Bight during summer. The result of these two spawning events is the appearance of two distinct size groups of juvenile bluefish during autumn; a spring spawned cohort with fish approximately 15-25 cm in length and a summer spawned cohort with fish approximately 4-14 cm in length (Able and Fahay 1998). Shepherds (2006) summarized that fish from the two spawning cohorts mix extensively during the year and constitute a single genetic stock (Graves et al. 1992). Bluefish are voracious predators and feed primarily on squid and fish (Buckel et al. 1999; Fahay et al*.* 1999).

EFH is identified for major estuaries between Penobscot Bay, Maine and the St. Johns River, Florida for juvenile and adult forms of bluefish (NMFS 2010a). Egg and larval forms of bluefish have designated EFH restricted to the pelagic waters over the continental shelf along Florida's coast. Inshore EFH has not been designated and; therefore, are not within the proposed project area. In general, juvenile bluefish occur in South Atlantic estuaries March through December and adults occur from May through January within the "mixing" and "seawater" zones (Shepherd 2006; Shepherd and Packer 2006). Juvenile bluefish may be encountered in the areas offshore of the project area, while adult bluefish may be encountered year round in the vicinity of the proposed project area.

2.2.2.1 Summary of Impacts to Bluefish

The project area includes sand bottom, rock, salt marsh, and water column that may be used by these managed fishes and their prey. The proposed project would impact a relatively small area of the sand and rock bottoms, and the impacts would be minor and short-term within St. John's River. Some possible refuge and related prey may be permanently lost due to the impact of material placement along the beaches south of the inlet. The proposed project will cause localized turbidity during construction; however, turbidity would be minimized using best management practices so that any impacts would be minor and temporary. These fishes and possible prey would be temporarily displaced, but should quickly return to the project area. While bluefish are common in the offshore waters and may utilize nearshore habitats, impacts should be minor from dredging impacts in the river. Previous extensive sampling of fishes in the vicinity of the project area showed no bluefish in the tidal estuaries over a variety of seasons (Dennis et al. 2001).

2.2.3 Summer Flounder

Summer flounder generally occur in shallow coastal and estuarine waters during warmer months and occupy outer continental shelf areas in colder months. Their range has been shown to extend from Nova Scotia to Florida (Packer et al. 1999). All estuaries where summer flounder were identified as being present have been designated EFH for larvae, juveniles, and adults. Estuaries include those from Albemarle Sound to Broad River, as well as the St. Johns and Indian rivers (Packer et al. 1999; NMFS 2010b). Larvae, juvenile, and adult summer flounder may be present within the St. Johns River in spring/summer months and ingress/egress during the winter season.

HAPCs are designated within juvenile and adult EFH to include all species of macroalgae, seagrasses, and freshwater and tidal macrophytes in any size bed, as well as loose aggregations (NMFS 2010b). These HAPCs may be encountered within the proposed project area outside of the main navigation channel (Figure 1).

2.2.3.1 Summary of Impacts to Summer Flounder

The project area includes sand bottom, rock, salt marsh, and water column that may be used by these managed fishes and their prey. The project would impact a relatively small area of sand and rock bottoms, and the impacts would be minor and short-term. Some possible refuge and related prey may be lost in regards to the impact to the rock bottom, and sandy areas. The proposed project will cause localized turbidity during construction; however, turbidity would be minimized using best management practices so that any impacts would be minor and temporary. These fishes and possible prey would be temporarily displaced, but should quickly return to the project area. HAPC may be included in the project area; however, were not identified during previous habitat characterizations of the area (WAR 2009).

2.2.4 South Atlantic Snapper-Grouper Complex

The St. Johns River is designated as EFH and HAPC for species of the Snapper-Grouper Complex that are listed under the Affected Fishery Management Plans and Fish Stocks of the Comprehensive EFH Amendment (SAFMC 1998). Members of this complex have been collected in the vicinity of the project area (FIM 2009). Collectively these species, representing ten different families, are all members of the 73 species Snapper-Grouper Complex as outlined by SAFMC (1998). The association of these fishes with coral or hardbottom structure, vegetated and unvegetated inshore areas during some period of their life cycle, and their contribution to a reef fishery ecosystem is why they are included in the snapper-grouper plan. A discussion of how these fishes utilize the various inshore habitat communities present within the proposed project area follows.

2.2.4.1 Life History

2.2.4.1.1 Balistidae

Collectively, triggerfishes inhabit shallow inshore areas (e.g., bays, harbors, lagoons, sandy areas, grassy areas, rubble rock, coral reefs, artificial reefs, or dropoffs adjacent to offshore reefs) to offshore waters as deep as 275 m. These triggerfish, especially the gray and queen triggerfish are an important component of the reef assemblage of both natural and artificial reefs (Vose and Nelson 1994). Information regarding balistid reproduction is limited and varied (Thresher 1984). The basic balistid (e.g., gray triggerfish) spawning behavior involves the production of dermersal, adhesive eggs that are thought to stick to corals and algae near or on the bottom. On the other hand, spawning of both the ocean and queen triggerfish takes place well off the bottom over relatively deep water where pelagic eggs are released. Unfortunately, egg and larval development is poorly understood regarding most species; however, a long (≥ 1 yr) planktonic stage appears common for many species. As juveniles, it has been suggested that they are planktonic, taking refuge among floating masses of *Sargassum* (Johnson and Saloman 1984). During this stage of development, the diet consists of primarily zooplankton associated with *Sargassum* or drifting in the water column. The exact timing of the environmental cues that trigger settlement is not well understood. However, juvenile gray triggerfish as small as 16-17 cm SL have been reported to colonize hardbottom habitats (Thresher 1984). After juveniles take on a benthic existence, their diet shifts to benthic fauna including algae, hydroids, barnacles, and polychaetes. All triggerfish feed diurnally and are well adapted to prey upon hard-shell invertebrates, especially adults. The diet of adult ocean triggerfish includes large zooplankton and possibly drifting seagrasses, algae, mollusks, and echinoderms. Adult gray and queen triggerfish feed primarily on sea urchins, but in their absence, will shift to other benthic invertebrates such as crabs, chiton, and sand dollars (Frazer et al. 1991; Vose and Nelson 1994). All three triggerfishes are commercially important (especially the queen triggerfish) in the aquarium trade and to some extent as a gamefish.

2.2.4.1.2 Carangidae

The St. Johns River is designated as EFH for carangid species because they utilize the offshore and possibly inshore areas adjacent to the proposed project area. Spawning of the bar jack, yellow jack, blue runner, and the crevalle jack takes place in offshore waters associated with a major current system such as the Gulf Stream from February through September (Berry 1959). Consequently, these four species have an offshore larval existence. Data indicates that peak spawning months for blue runners is May through July (Shaw and Drullinger 1990). Although spawning data regarding the greater amberjack doesn't exist, it is assumed that it is similar to the other four species. As young juveniles, crevalle jack migrate into inshore waters at about 20 mm SL; whereas, blue runners don't migrate into inshore areas until their late juvenile stage (Berry 1959). Young bar jacks have a tendency to remain offshore and yellow jacks occur inshore only occasionally as juveniles (Berry 1959). Based on collections of juveniles regarding these four species, there is some indication a mobile, northward population of developing young in the Gulf Stream developed from spawning occurring in more southern waters (Berry 1959).

As juveniles and sub-adults, blue runners occur singly or in schools while juveniles have a high affinity for *Sargassum* and other floating objects in the Gulf Stream off southeast Florida (Goodwin and Finucane 1985). Blue runners are a fast growing, long-lived species which attains 75% of its maximum size in its first 3 - 4 years of life (Goodwin and Johnson 1986). The greater amberjack is a far ranging species that inhabits inlets, shallow reefs, rock outcrops, and wrecks with reef fishes such as snappers, sea bass, grunts, and porgies (Manooch and Potts 1997a). They are generally restricted to the continental shelf to depths as great as 350 m (Manooch and Haimovici 1983). Small individuals (< 1 m SL) are usually found in water < 10 m deep while larger individuals frequent waters 18 - 72 m deep (Manooch and Potts 1997b). Greater amberjack are a fast growing species and are recruited to the headboat fishery in the Gulf by age 4 and fully recruited to the fishery by age 8 (Manooch and Potts 1997a; Manooch and Potts 1997b).

All carangids are popular sport fishes among recreational fishers, but not as popular commercially where they are harvested using handlines, bottom longlines, and in some cases traps and trawls. Some Florida fishers feel that amberjack are being exposed to too much fishing pressure, especially owing to their attraction to reefs which make them an easy target for overfishing (Manooch and Potts 1997a). However, as of 1997 there is no evidence of overfishing in both the Gulf of Mexico and southeast Florida (Manooch and Potts 1997b).

2.2.4.1.3 Ephippidae

The St. Johns River and its tributaries are designated as EFH for the spadefish because as a juvenile, it inhabits shallow sandy beaches, estuaries, jetties, wharves, and other inshore areas, as well as deeper offshore habitats as adults. Spawning, which takes place from May to September, involves an offshore migration as far as 64.4 km (Chapman 1978; Thresher 1984). Although no data exists regarding egg and larvae development in nature, small individuals (approximately 1-2 cm TL) appear inshore in early summer (Walker 1991). These small juveniles are commonly observed drifting motionless alongside vegetation (e.g., *Sargassum*). It has been suggested that spadefish mimic floating debris and vegetation to escape predation. As spadefish mature, they move further offshore where large schools will take residence around wrecks, oil and gas platforms, reefs, and occasionally open water. Spadefish are opportunistic feeders; preying upon a variety of items including small crustaceans, worms, hydroids, sponges, sea cucumbers, salps, anemones, and jellyfish. In certain areas, the spadefish is an important game fish.

2.2.4.1.4 Haemulidae

Collectively, grunts inhabit shallow inshore areas (e.g., estuaries, mangroves, jetties, piers, and seagrass beds), coral reefs, rock outcrops, and offshore waters as deep as 110 m. Although most of the life history data concerning grunts (Cummings et al. 1966; Manooch and Barans 1982; Darcy 1983; McFarland et al. 1985; Sedberry 1985) are from studies of tomtate, white grunt, French grunt, blue stripe grunt, and the margate, the general information can probably be applied to the other species as well. As a reef-dwelling species, grunts are probably similar to other roving benthic predators such as snappers and groupers that migrate to select spawning sites along the outer reef and participate in group spawning at dusk. Some data suggests that spawning takes place over much of the year, while other data suggests spawning peaks in later winter and spring (Manooch and Barans 1982; Darcy 1983). The eggs are pelagic as well as the planktonic larvae. After this pelagic larval stage that may last several weeks, they settle to the bottom as benthic predators (Darcy 1983). The juveniles are commonly found in seagrass beds, near mangroves and other inshore, shallow areas. Studies in the Caribbean regarding French grunt suggested that fertilization and settlement was associated with the lunar cycle (quarter moon, rather than the full or new moon) and daily tidal cycles (rising and falling tides) (McFarland et al. 1985).

Juveniles are diurnal planktivores that tend to feed higher in the water column than adults on amphipods, copepods, decapods, and small fishes (Darcy 1983; Sedberry 1985). The transformation to adult involves a change in feeding strategy from diurnal planktivore to nocturnal benthic foraging. Most grunts take refuge near the reef in schools, but at dusk they disperse and forage over the reef, along sandy flats, and grass beds for crustaceans, fishes, mollusks, polychaetes, and ophiuroids. Because of these nocturnal foraging migrations, grunts are a major source of food for higher tropic level piscivorous fishes. In addition, they are very important to hardbottom reef-related fisheries regarding the energy transfer from sandy expanses to these reefs (Darcy 1983).

Several species of grunt such as the tomtate and white grunt have some commercial and recreational importance. Tomtate are commonly caught by sport fishers from shore, bridges, jetties, and inshore waters by boat. In the southeastern United States, the hook and line fishery is the most important method of commercial harvest regarding tomtate (Darcy 1983). In addition, tomtate are collected using traps, trawls, and seines off southeast Florida. Commercially, tomtate are usually discarded or cut up and used as bait for the grouper or snapper fishery. Similarly, white grunt are commercially harvested by hook and line along the southeast United States and is also a common sport species.

2.2.4.1.5 Labridae

Fishes of the Labridae family are included within the Snapper-Grouper complex. In particular, species such as the puddingwife and hog snapper are of particular importance. While not common within the St. Johns River, they are included for life history comparisons to other species of the complex found within the proposed project area.

The EFH for both species ranges from shallow reef and patch reefs, areas of hard sand and rock, and/or along areas inshore or offshore of the main reef. The puddingwife appears to be depth restricted, as it is rare to find this species in waters deeper than 13.3 m; while the hogfish inhabits areas as shallow as 3.3 m deep (Thresher 1980). Reproduction in wrasses involves a complex reproductive system based on protogynous hermaphroditism which features a complex socio-sexual system involving sex reversal, alternate spawning systems and variable color patterns (Thresher 1980). Both species participate in group (the dominant or terminal male with a harem of females) broadcast spawning that occurs along the outer edge of a patch reef or on an extensive reef complex along the outer shelf during the summer months (Thresher 1984). Hogfish spawn during the late afternoon or early evening hours, while puddingwife spawning is synchronized with strong tidal or shoreline currents. Although the exact duration of both the planktonic egg and larval stage is unknown, some records suggest that the latter may be as short as one month before the larvae settle out. Newly settled hogfish and puddingwifes use common areas around grass flats and the shallow reef, respectively. The smallest juveniles on record collected on reefs are approximately 10 mm SL. Other data suggests that puddingwife as small as 30 mm SL may be sexually active. As a benthic predator, the diet of adult hogfish consists of mollusks, echinoderms, and small crustaceans (primarily crabs). Owing to their large size, hogfish are popular with sport fishers.

2.2.4.1.6 Lutjanidae

The EFH of snappers ranges from shallow estuarine areas (e.g., vegetated sand bottom, mangroves, jetties, pilings, bays, channels, mud bottom) to offshore areas (e.g., hard and live bottom, coral reefs, and rocky bottom) as deep as 400 m (Allen 1985; Bortone and Williams 1986). Like most snappers, these species participate in group spawning, which indicates either an offshore migration or a tendency for larger, mature individuals to take residency in deeper, offshore waters. Data suggests that adults tend to remain in one area. Both the eggs and larvae of these snappers are pelagic (Richards et al. 1994). After an unspecified period of time in the water column, the planktivorous larvae move inshore and become demersal juveniles. The diet of these newly settled juveniles consists of benthic crustaceans and fishes. Juveniles inhabit a variety of shallow, estuarine areas including vegetated sand bottom, bays, mangroves, finger coral, and seagrass beds. As adults, most are common to deeper offshore areas such as live and hardbottoms, coral reefs, and rock rubble. However, adult mutton, gray, and lane snapper also inhabit vegetated sand bottoms with gray snapper less frequently occurring in estuaries and mangroves (Bortone and Williams 1986). The diet of adult snappers includes a variety fishes, shrimps, crabs, gastropods, cephalopods, worms, and plankton. All species are of commercial and/or recreational importance. In particular, the mutton, gray, lane, and yellowtail snapper comprise the major portion of Florida's snapper fishery (Bortone and Williams 1986).

2.2.4.1.7 Serranidae

The EFH of sea bass ranges from shallow estuarine areas (e.g., seagrass beds, jetties, mangrove swamps) to offshore waters as deep as 300 m (Heemstra and Randall 1993; Jory and Iverson 1989; Mercer 1989). Like all other serranids, the six species are protogynous hermaphrodites; functioning initially as females only to undergo a sexual transformation at a later time to become functional males. In addition, like all other serrranids, these species produce offshore planktonic eggs, moving into shallow, inshore water during their post-larval benthic stage. Juveniles inhabit estuarine, shallow areas such as seagrass beds, bays, harbors, jetties, piers, shell bottom, mangrove swamps, and inshore reefs. Juveniles feed on estuarine dependent prey such as invertebrates, primarily crustaceans, which comprise the majority of their diet at this developmental stage. As sub-adults and adults, migration occurs further offshore as refuge consists of rocky, hard, or live bottom, on artificial or coral reefs, in crevices, ledges, or caverns associated with rocky reefs. During this stage in their lives, the bulk of their diet consists of fishes supplemented with crustaceans, crabs, shrimps, and cephalopods. Except for the Goliath grouper, the sea bass species have some importance to commercial and/or recreational fisheries.

2.2.4.1.8 Sparidae

EFH for porgies ranges from shallow inshore waters (e.g., vegetated areas, jetties, piers, hard and rock bottoms), to deeper offshore waters with natural or artificial reefs, offshore gas and oil platforms, or live bottom habitat (Darcy 1986). Although nothing is known regarding the sexuality of the jolthead porgy, it is most likely a hermaphroditic species which is widely documented in sparids (Thresher 1984). On the other hand, the sheepshead has been determined to be a protogynous hermaphrodite through histological investigations (Render and Wilson 1992). Information regarding tropical sparids is limited, but in general, it suggests long spawning seasons. Little is known about spawning behavior, but it is presumed that both the sheepshead and the jolthead porgy produce pelagic eggs some distance off the bottom. Aggregations have not been documented. Settlement of sheepshead larvae to the bottom occurs at about 25 mm TL (Thresher 1984). Based on their dentition, both species are well suited for benthic feeding of sessile and motile invertebrates (e.g., copepods, amphipods, mysids, shrimp, bivalves, gastropods) which are bitten off from hard substrates and vegetation. Neither sparid is considered a schooling species, although they will form small groups composed of several individuals occasionally. There is no direct commercial or sport fishery associated with either sparid; however, both are fished in coastal waters. Both species are an important constituent of communities in shallow water and live bottom communities in deeper water (Darcy 1986).

2.2.4.2 Summary of the Impacts to the Snapper-Grouper Complex Fishes

The proposed project area includes sand bottom, rock, salt marsh and water column that may be used by these managed fishes and their prey. The project would impact a relatively small area of the sand and rock bottoms, and the impacts would be minor and short-term. Some possible refuge and related prey may be lost in regards to the impact to the rock bottom, and sandy areas. HAPC for the snapper-grouper complex comprised a large part of the proposed project area. Dredging and blasting activities, as well as, disposal of dredge material may directly and indirectly impact habitats utilized by this group of fishes. Previous studies have shown that many of these fishes are common in the proposed work area (SJRWMD 1994; Dennis et al. 2001). The project will cause localized turbidity during construction; however, turbidity would be minimized using best management practices so that any impacts would be minor and temporary. These fishes and possible prey would be temporarily displaced, but should quickly return to the project area. These fishes are common in the tributaries of the St. Johns River adjacent to the project area and these areas will serve as refuge for fishes displaced during construction.

2.2.5 Coastal Migratory Pelagics Complex

The St. Johns River located in Duval County, Florida is designated as EFH for five species of coastal migratory pelagic fishes that are listed under the Affected Fishery Management Plans and Fish Stocks of the Comprehensive EFH Amendment (SAFMC 1998). These include the king mackerel, cero mackerel, Spanish mackerel, little tunny and cobia. Collectively, these five species, representing two different families, are all members of the Coastal Migratory Pelagics Fish Species as outlined by SAFMC (1998). The association of these fishes or their prey with offshore features or inshore waters during some period of their life cycle and their contribution to the fishery ecosystem is why they are included in this complex. A discussion of how these fishes utilize the various inshore habitats and adjacent communities present within the proposed project area follows.

2.2.5.1 Life History

2.2.5.1.1 Rachycentridae

Cobias are distributed worldwide in tropical, subtropical, and warm temperate waters where they inhabit estuarine and shelf waters depending on their life stage. They appear to associate with structures such as pilings, wrecks and other forms of vertical relief (e.g. oil and gas platforms) and favor the shade from these structures (Mills 2000). Cobia spawn offshore where external fertilization takes place in large spawning aggregations; however, the pelagic eggs have been collected at both inshore and offshore stations. Based on past collections of gravid females, spawning takes place from mid-May, extending through the end of August off South Carolina (Shaffer and Nakamura 1989). Consequently, spawning may start slightly early off the southeast coast of Florida. Eggs have been collected in the lower Chesapeake Bay inlets, North Carolina estuaries, in coastal waters 20 - 49 m deep, and near the edge of the Florida Current and the Gulf Stream (Ditty and Shaw 1992). Ditty and Shaw (1992) suggested that cobia spawn during the day since all the embryos they examined were at similar stages of development. Cobia exhibit rapid growth and may attain a length of 2 m SL and are known to live 10 years (Shaffer and Nakamura 1989). Although females grow faster than males, they attain sexual maturity later in life. Sexual maturity is attained by males at approximately 52 cm SL during the second year and at approximately 70 cm SL for females during their third year (Shaffer and Nakamura 1989). They are adaptable to their environment and can utilize a variety of habitats and prey. Cobia are voracious predators that forage primarily near the bottom, but on occasion do take some prey near the surface. They typically favor crabs, and to a much less extent other benthic invertebrates and fishes. No predator studies have been conducted, but dolphin fish have been known to feed on small cobia. Adults may be found solitary or in small groups and are known to associate with rays, sharks, and other larger fishes. Cobia is fished both commercially and recreationally; however, the commercial harvest is mostly incidental in both the hook and line and net fisheries. The recreational harvest is primarily through charter boats, party boats, and fishing from piers and jetties. Tagging studies have documented a north-south, spring-fall migration along the southeast United States and an inshore-offshore, spring-fall migration off South Carolina (Ditty and Shaw 1992).

2.2.5.1.2 Scombridae

The habitats in the vicinity of the proposed project area are designated as EFH for four scombrid species (SAFMC 1998; NMFS 2010a). Collectively, the EFH of these epipelagic scombrids ranges from clear waters around coral reefs, and inshore and continental shelf waters (Collette and Nauen 1983). Spawning of king and Spanish mackerel takes place May through September with peaks in July and August. The cero is thought to spawn year round with peaks in April through October, whereas little tunny spawn from April to November. Batch spawning takes place in tropical and subtropical waters, frequently inshore. The eggs are pelagic and hatch into planktonic larvae. Both king and Spanish mackerel are involved in migrations along the western Atlantic coast. With increasing water temperatures, Spanish mackerel move northward from Florida to Rhode Island between late February and July, and back in the fall (Collette and Nauen 1983). King mackerel have been reported to migrate along the western Atlantic coast in large schools; however, there appears to be a resident population in south Florida as this species is available to sport fishermen year round (Collette and Nauen 1983). Although the little tunny is epipelagic, it typically inhabits inshore waters in schools of similar size fish and/or with other scombrids (Collette and Nauen 1983). The diet of these scombrids consists of primarily fishes and to a lesser extent, penaeid shrimp and cephalopods. The fishes that make up the bulk of their diet are small schooling clupeids (e.g., menhaden, alewives, thread herring, anchovies), atherinids, and to a lesser extent, jack mackerels, snappers, grunts, and half beaks (Collette and Nauen 1983). The king and Spanish mackerel are important both commercially and recreationally. The king mackerel is a valued sport fish year round in Florida, while the sport fisheries for Spanish mackerel in southern Florida are concentrated in the winter months. The cero is a valued sport fish that is taken primarily by trolling. The little tunny is not of commercial or recreational interest.

2.2.5.2 Summary of Impacts to the Coastal Migratory Pelagics Complex Fishes

Direct and indirect impacts to species managed under the Coastal Migratory Pelagic complex should be short-term and minimal. Most of the species within this complex utilize offshore habitats. Should material be used for beach placement or placed in the ODMDS, temporary indirect impacts may occur. Impacts to infauna in the nearshore placement areas will occur and may have some impact on prey species for Coastal Migratory Pelagics (Appendix A). The proposed project will result in localized turbidity during construction; however, turbidity would be minimized using best management practices so that any impacts would be minor and temporary. These fishes and possible prey would be temporarily displaced, but should quickly return to the project area.

2.2.6 Highly Migratory Atlantic Species

Overall, EFH for Highly Migratory Species includes the marine and estuarine water column habitats within and adjacent to the proposed project area. Thirteen species of sharks may be present within the area of the St. Johns River (Table 1) (NMFS 2006). These species however, appear to be relatively rare within the river itself (Dennis et al. 2001; FIM 2009). There are no HAPC within the proposed project area for Highly Migratory Species, and only one species of the 13, the sandbar shark, has any type of HAPC status (NMFS 2010a).

Only the Atlantic sharpnose and bonnethead sharks are considered to be year-round residents of the area surrounding the St. Johns River, while the blacknose and blacktip sharks can be seasonally abundant. The other species listed are either rare within the area or occur in seasonal migrations up and down the coast (NMFS 2006).

2.2.6.2 Summary of Impacts to the Highly Migratory Atlantic Species

Direct and indirect impacts to species managed under the Highly Migratory Atlantic Species complex should be short-term and minimal. Most of the species within this complex utilize offshore habitats; however, a few species do utilize the nearshore and in-shore waters during their life histories. In particular, the bull shark, Atlantic sharpnose shark, and bonnethead shark have been documented in the proposed project area (Dennis et al. 2001; FIM 2009).

Indirect impacts to these species in the in-shore areas of the proposed project area should be temporary. These species are highly motile and most likely utilize these nearshore waters for foraging. The in-shore habitats of the St. Johns River within the proposed project area are not listed as being used by these species for breeding or neonatal sharks (NMFS 2010a). Overall, these species are rare in the vicinity of the project area and impacts will therefore be temporary in nature (Dennis et al. 2001).

Indirect impacts to these species in the offshore habitats may occur should material be used for beach placement or placed in the ODMDS, then temporary impacts may occur. The proposed project will result in localized turbidity during construction; however, turbidity would be minimized using best management practices so that any impacts would be minor and temporary. These fishes and possible prey would be temporarily displaced, but should quickly return to the project area.

2.3 Associated Species

Associated species consists of living resources that occur in conjunction with the managed species discussed above. These living resources would include the primary prey species and other fauna that occupy similar habitats.

2.3.1 Invertebrates

Dredging and blasting associated with deepening would result in direct adverse effects on invertebrate species in the proposed project area. Initially, this will result in a significant but localized reduction in the abundance, diversity, and biomass of the immediate fauna. Species affected most are those that have limited capabilities or are incapable in avoiding the dredging activities. The fauna most affected would predominantly include invertebrates such as crustaceans, echinoderms, mollusks, polychaetes, and annelids. However, due to the relatively small area that will be impacted as viewed on a spatial scale, impacts to the benthic community will be minimal due to the relatively short period of recovery regarding infaunal communities following dredging activities (Culter and Mahadevan 1982; Saloman et al. 1982). Adjacent areas not impacted would most likely be the primary source of recruitment to the impacted area. Direct impacts to invertebrates are also anticipated by placement of material in the ODMDS and nearshore placement areas. These habitats, in particular the nearshore areas, hold many invertebrate species that are prey for a variety of fishes (Appendix A). Similar to the dredging impacts, these species are expected to recover within two years.

Zooplankton are primarily filter feeders and suspended inorganic particles can foul the fine structures associated with feeding appendages. Zooplankton that feed by ciliary action (e.g., echinoderm larvae) would also be susceptible to mechanical affects of suspended particles (Sullivan and Hancock 1977). Zooplankton mortality is assumed from the physical trauma associated with dredging activities (Reine and Clark 1998). The overall impact on the zooplankton community should be minimal due to the limited extent and transient nature of the sediment plume.

2.3.2 Fishes

Associated fish species outside of those addressed in the scope of this EFH assessment may also be impacted. Over 170 species of coastal and estuarine fish have been identified for the entire St. Johns River (SJRWMD 1994; Dennis et al. 2001; FIM 2009). These fishes may play important roles in the various life stages of managed species, especially as prey species.

The larvae of the managed fish species discussed in this EFH assessment are hatched from planktonic eggs (excluding the gray triggerfish) and the larvae are also planktonic. The primary source of larval food is microzooplankton with a dietary overlap in many species and specialization (Sale 1991). Algae is most likely food for only the youngest larval stages of certain species, or for those larvae that are very small after hatching, and then only for a short time. The algae-eating larvae eventually switch to animal food while they are still small. At this time, varying life history stages of copepods become the dominant food and to a lesser extent cladocerans, tunicate and gastropod larvae, isopods, amphipods, and other crustacea.

Larval feeding efficiency depends on many factors such as light intensity, temperature, prey evasiveness, food density, larva experience, and olfaction to mention a few (Gerking 1994). Larval fishes are visual feeders that depend on adequate light levels in the water column which reduces the reaction distance between larval fish and prey. Suspended sediment and dispersion due to dredging activities will temporarily increase turbidity levels in the proposed project area. This will reduce light levels within the water column which may have a short term negative effect regarding feeding efficiency. In addition, turbidity can affect light scattering which will impede fish predation (Benfield and Minello 1996). However, because the sediment plumes are transient and temporary, and the area to be impacted is relatively small when examined on a spatial scale, the overall impact to the larval fish population and consequently, the adult population should be minimal (Sale 1991). The majority of larval fish mortality will be attributed to the physical trauma associated with the dredging activities.

Similar to larval fishes, both juvenile and adult fishes are primarily visual feeders. Consequently, the visual effects of turbidity as described above will apply. Also, suspended sediment can impair feeding ability by clogging the interraker space of the gill rakers or the mucous layer of filter feeding species (Gerking 1994). However, because these fishes have the ability to migrate away from the dredging activities, the impact of the sediment plumes should be minimal. Although few adult fishes have been entrained by dredging operations (McGraw and Armstrong 1988; Reine and Clark 1998), most juvenile and adult fishes again have the ability to migrate away from the dredging activities. Consequently, dredging operations would have minimal effects on juvenile and adult fishes in the area. In addition, the reduction of benthic epifaunal and infaunal prey, and pelagic prey in the immediate area would have little effect on juvenile and adult fishes because they can migrate to adjacent areas that have not been impacted to feed.

2.3.3 Summary of Impacts to Associated Species

The majority of juvenile and adult fishes would be displaced to adjacent habitat during dredging operations; consequently, mortality of these fishes should be minimal. Only those species that produce demersal eggs and that comprise the demersal ichthyofauna could potentially be impacted more heavily than their pelagic counterparts. Mortality of demersal eggs and larvae would be expected from the physical trauma associated with dredging operations. Suspended sediments produced by these operations can affect the feeding activity of pelagics as outlined earlier; however, the impact to these fishes should be minimal due to the limited extent and transient nature of the sediment plume.

2.4 Cumulative Impacts

Cumulative impact is the "impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (federal or non-federal) or person undertakes such other actions (40 CFR 1508.7)." Cumulative impacts associated with this project would include the impacts from similar activities within the same geographic region. A summary of these impacts is included in Table 3. There were nine prior dredging projects within the vicinity of the project area from 2001-2010. These construction efforts consisted of projects that utilized various dredging techniques and placement areas. Overall, each of these projects impacted EFH. The most common impacts would be to water column and un-vegetated soft bottom habitats. Since these impacts were most likely temporary and the infaunal benthic community associated with soft bottom sand substrates recovers quickly, the overall cumulative impact on EFH from dredging within the St. Johns River should be short-term and minimal.

3.0 CONCLUSIONS

The proposed improvements to Jacksonville Harbor navigation channel in the St. Johns River will impact EFH. These include impacts to HAPC, especially within the inlet, which may alter important migratory routes in and out of the river system. These impacts however, will be limited to areas of dredging and occur over a limited area within the entire river system (Figure 1). The use of best management practices should limit the extent and duration of turbidity impacts, which will temporarily alter fish dynamics in the vicinity of the construction activities. Permanent losses of habitat will occur, but those species inhabiting these areas are expected to recover quickly. Fishes in St. Johns River near the construction activities should have adjacent similar habitats to utilize during times of construction. Timing of construction activities around times of high migration (e.g. penaeid shrimp) for some species will further reduce these impacts; however, some impact to juveniles in the system will be expected. Overall, the impacts to EFH and HAPC related to the navigational improvements at Jacksonville Harbor will be temporary and will not result in significant effects on managed species. Appropriate mitigation and monitoring for the proposed expansion of Bartram Island will be further evaluated once a National Economic Development Plan is developed and approved.

Table 3. Summary of prior dredging projects within the vicinity of the proposed project area.

Project year	Construction Dates	Dredging Method	Quantity of Material (CY)	Disposal Area
2001	08/21/00-04/16/01	Cutter Suction/Hopper	1,500,000	Bartram Island DMMA
2002	07/12/02-05/03/03	Clamshell	260,000	Upland
2002	11/11/02-01/07/03	Cutter Suction/Hopper	3,500,000	Upland/ODMDS/Beach
2004	08/20/04-11/09/04	Hopper	267,000	Bartram Island DMMA
2005	09/08/05-09/26/05	Hopper	130,000	Bartram Island DMMA
2006	07/01/06-08/10/06	Hopper	136,500	Buck Island
2007	08/16/07-04/11/08	Clamshell/Hopper	1,067,000	Upland/ODMDS
2009	09/12/09-07/07/10	Cutter Suction/Hopper	2,680,000	Bartram Island DMMA
2010	05/13/10-06/08/10	Cutter Suction/Hopper	112,000	Buck Island

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APPENDIX A

NEARSHORE SIDE-SCAN SONAR AND BENTHIC SURVEYS

Technical Memorandum
Nearshore Side-scan Sonar and Benthic Surveys
Jacksonville Harbor Navigation Study
Jacksonville, Florida

Introduction

The Jacksonville Port Authority has requested the U.S Army Corps of Engineers (USACE) study the feasibility of further deepening the federal system of channels within Jacksonville Harbor. The study objectives include evaluating the potential navigation benefits of deepening the main ship channel at one-foot increments from the existing 40-foot project depth up to a 50-foot project depth. The study encompasses the entrance channel to river mile 20; deepening the West Blount Island Channel at one-foot increments from the existing 38-foot project depth to a 50-foot project depth; widening portions of the channel (Training Wall Reach, St. Johns Bluff Reach, SW Blount Island Channel, Broward Pt. Turn, Drummond Creek Range, Trout River Cut Range, and the Terminal Channel Reach); and creating turning basins adjacent the Blount Island Terminal and the Terminal Channel Reach. The work would be performed with various dredges, including the use of explosives required for some rock removal. Up to 43,000,000 cubic yards of dredged material consisting of rock and unconsolidated substrate would be placed in a variety of disposal areas. Two nearshore placement areas are being considered south of the Jacksonville Harbor entrance channel (Figure 1).

Dial Cordy and Associates Inc. (DC&A) was contracted by the Jacksonville District USACE under contract W912EP-10-F-0016, to conduct a field survey characterizing Essential Fish Habitat (EFH) within the proposed pipe and barge nearshore placement areas (Figure 1). These locations are estimated at 200 and 451 acres, respectively. A side-scan sonar survey including the identification and delineation of bottom habitat(s) and substrate types within each nearshore area was conducted. The nearshore area substrates were assumed as unconsolidated (sand) sediments; however, side-scan sonar surveys determined if any hardbottom habitats were present. Benthic grab samples were also collected within each surveyed area and infauna analyses were conducted determining habitat utilization and the potential effects dredged material placement may have on EFH.

Methods

Side-Scan Sonar Survey

A side-scan survey of the potential beach placement areas was conducted to determine the bottom types present within each area (Figure 1). A Marine Sonic HDS 900 khz high definition side-scan sonar in conjunction with a Trimble sub-meter accurate DGPS and Hypack navigation software was used to survey each area. Survey lines were established within each area providing sufficient coverage determining each area's bottom types (Figure 2).

Benthic Infauna Survey

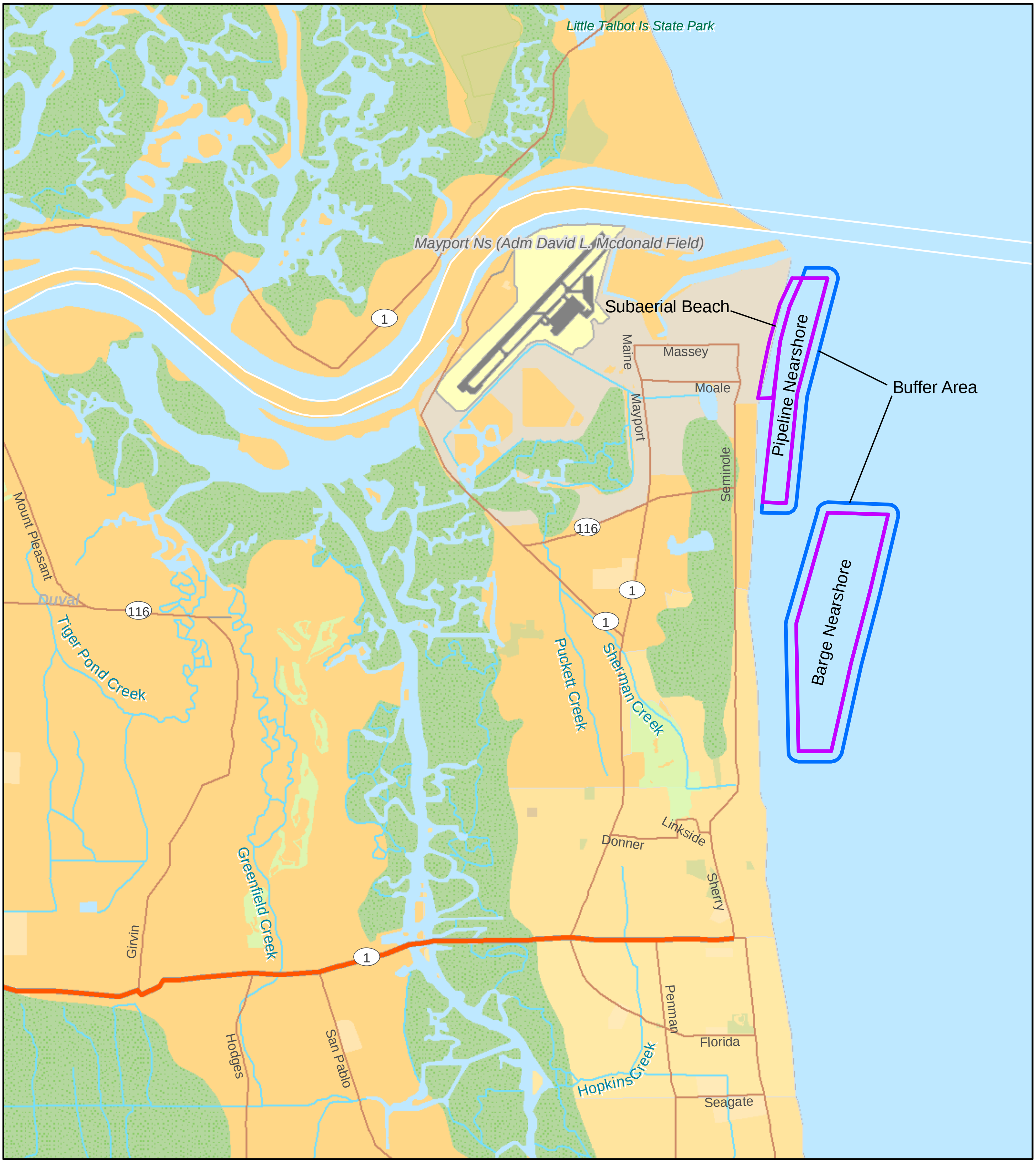
Benthic infauna was sampled using a standard Ponar grab, deployed three times at each sample location. Retrieved samples were composited and approximately one liter of the composited material was sub-sampled. The sub-sample was placed in a HDPE jar and preserved with 10% formalin. Samples were submitted to Barry Vittor and Associates for taxonomic analysis.

Results

The side-scan survey and habitat classification results show that all habitats in the nearshore areas consist of unconsolidated material (sand, sand with shell) (Figure 3). Sand with shell hash and scattered rubble occur along the south jetty. Benthic infauna analysis revealed a total of 342 individuals representing 47 different taxa over the six sampling locations (Tables 1 and 2). Polychaete and annelid worms were the most common infauna collected. Total numbers of taxa collected at each location ranged from 13 to 22 species, with total numbers of individuals ranging from 37 to 73. A complete list of species collected is shown in Table 3. Species richness, number of taxa, and species diversity generally increased from north to south (Table 1).

Potential Effects to EFH

Dredged material placement in the proposed nearshore areas would affect a total of 651 acres. This habitat is comprised entirely of open sand substrate and EFH effects would include unvegetated sandy bottoms and open water habitats. While managed species may be impacted (i.e. coastal migratory pelagics) the majority of the effects will be on associated and prey species for managed species. These effects however should be minor and temporary in nature and these species will re-colonize these nearshore areas quickly. These potential EFH effects are discussed in the Essential Fish Habitat Assessment Jacksonville Harbor Navigation Study, Duval County, FL (Dial Cordy and Associates Inc. 2010).



Legend

Current Operating Channel

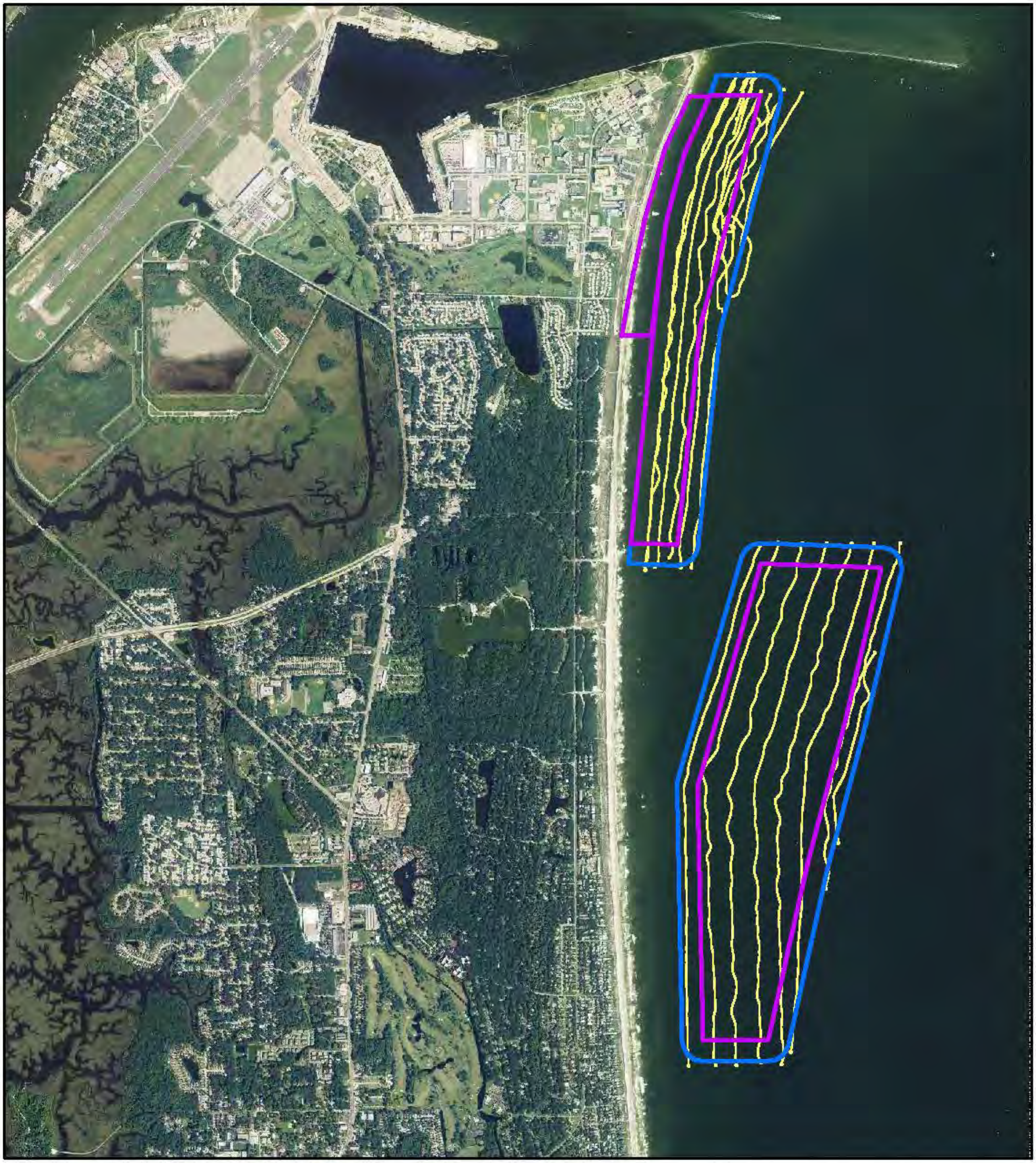
Nearshore Survey Area

Buffer Area (400 feet)

0 0.5 1 2 3 Miles

N

Proposed Nearshore Sand Placement and Pipeline Areas	
JACKSONVILLE HARBOR NAVIGATION STUDY	
Scale: 1 inch = 1 mile	Drawn By: MR
Date: October 2010	Approved By: SD
DIAL CORDY AND ASSOCIATES INC Environmental Consultants	J10-1154
	Figure 1

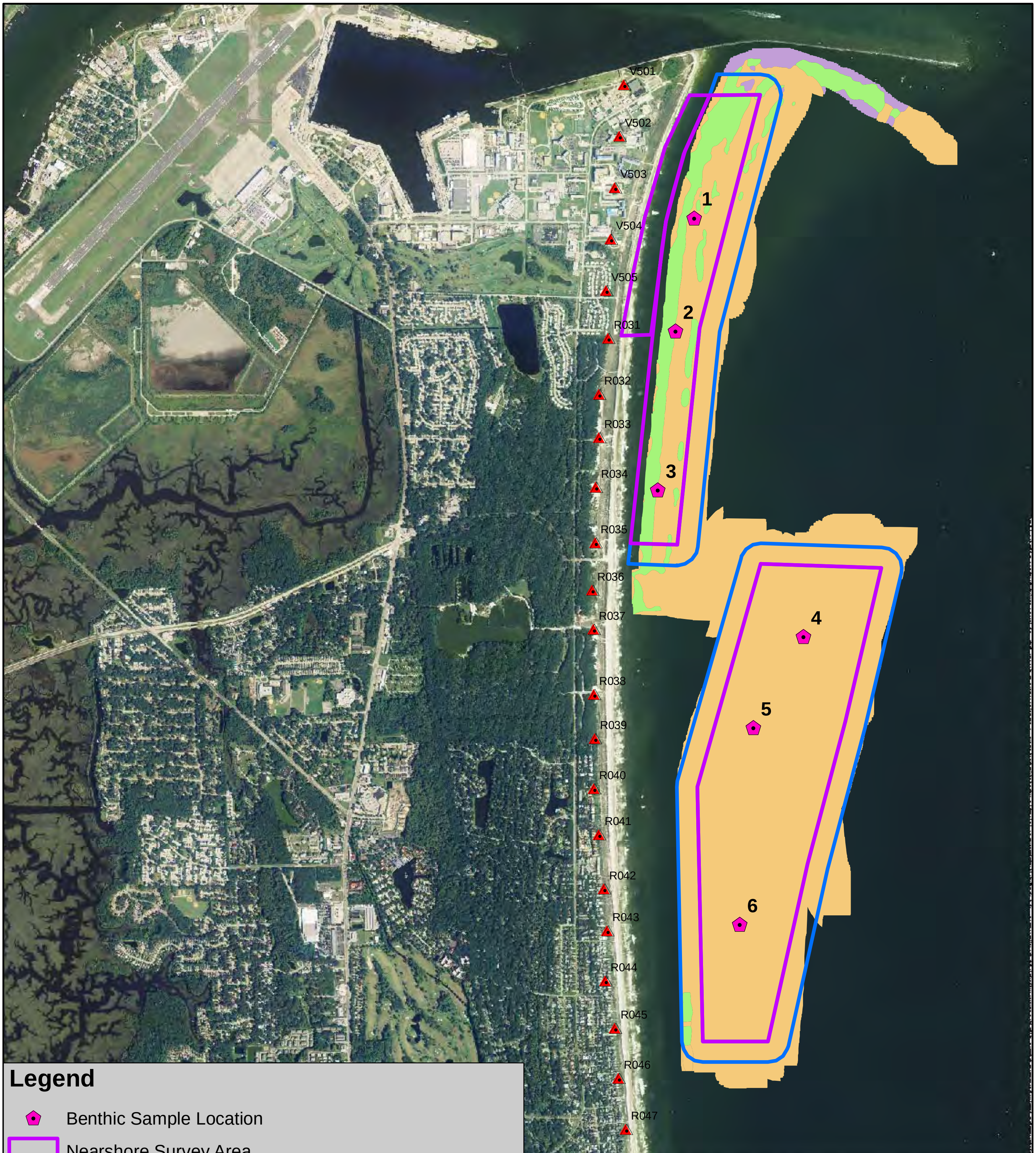


Legend

- Nearshore Survey Area
- Buffer Area (400 feet)
- Side-Scan Sonar Trackline

0 0.25 0.5 1 1.5 Miles

Side-Scan Sonar Tow Lines for Nearshore Survey	
JACKSONVILLE HARBOR NAVIGATION STUDY	
Scale: 1 inch = 0.5 mile	Drawn By: MR
Date: October 2010	Approved By: SD
DIAL CORDY AND ASSOCIATES INC Environmental Consultants	J10-1154
	Figure 2



Legend

- Benthic Sample Location
- Nearshore Survey Area
- Buffer Area (400 feet)

Nearshore Substrate Classification (Sidescan Sonar, Apr10)

- Sand
- Sand w/ shell hash
- Sand w/shell hash and scattered rock-rubble

0 0.25 0.5 1 1.5 Miles

Substrate Classification and Benthic Sampling Sites	
JACKSONVILLE HARBOR NAVIGATION STUDY	
Scale: 1 inch = 0.5 mile	Drawn By: MR
Date: October 2010	Approved By: SD
DIAL CORDY AND ASSOCIATES INC Environmental Consultants	J10-1154
	Figure 3

Table 1. Summary of community parameters.

Project: Dial Cordy 2010
Sample Date: April 2010

FAUNAL PARAMETERS

Station	Date (m/d/y)	Total No. Taxa	Mean No. of Taxa per Repl.	No. of Taxa per Repl. (Std Dev)	Total No. Individuals	Mean Density (nos/m2)	Density (Std Dev)	H' Shannon (log e)	d Diversity (log 2)	1/S Simpson Diversity	J' Pielou Evenness	D Margalef Richness	e Equitability
Station 1	4/1/2010	13	13.0	0.0	37	2467.0	0.0	2.23	3.21	8.22	0.87	3.32	1.01
Station 2	4/1/2010	14	14.0	0.0	57	3800.0	0.0	1.59	2.30	2.72	0.60	3.22	0.48
Station 3	4/1/2010	13	13.0	0.0	44	2933.0	0.0	1.94	2.79	4.68	0.75	3.17	0.75
Station 4	4/1/2010	18	18.0	0.0	65	4333.0	0.0	2.31	3.33	6.93	0.80	4.07	0.79
Station 5	4/1/2010	22	22.0	0.0	73	4867.0	0.0	2.51	3.62	8.19	0.81	4.89	0.80
Station 6	4/1/2010	20	20.0	0.0	66	4400.0	0.0	2.57	3.71	9.84	0.86	4.53	0.94

Table 2. Species occurrence at nearshore sampling stations.

Station ID	Phylum	Class	Order	Family	Taxon Name	No. Individuals
Station 1	Nemertea				Nemertea (LPIL)	1
Station 1	Rhynchocoela	Anopla	Paleonemertea	Tubulanidae	Tubulanus (LPIL)	4
Station 1	Annelida	Polychaeta	Phyllodocida	Nephtyidae	Nephtyidae (LPIL)	2
Station 1	Annelida	Polychaeta	Phyllodocida	Phyllodocidae	Phyllodoce arenae	1
Station 1	Annelida	Polychaeta	Spionida	Spionidae	Polydora cornuta	3
Station 1	Annelida	Polychaeta	Spionida	Spionidae	Spiophanes bombyx	5
Station 1	Annelida	Polychaeta	Terebellida	Ampharetidae	Hobsonia florida	1
Station 1	Mollusca	Bivalvia	Veneroida	Mactridae	Mulinia lateralis	11
Station 1	Mollusca	Gastropoda	Neogastropoda	Nassariidae	Nassarius acutus	1
Station 1	Arthropoda	Malacostraca	Amphipoda	Haustoriidae	Protohaustorius sp. C	3
Station 1	Arthropoda	Malacostraca	Cumacea	Diastylidae	Oxyurostylis smithi	1
Station 1	Arthropoda	Malacostraca	Decapoda	Paguridae	Pagurus (LPIL)	3
Station 1	Echinodermata	Echinoidea	Clypeasteroida	Mellitidae	Mellita quinquiesperforata	1
Station 2	Rhynchocoela	Anopla	Paleonemertea	Tubulanidae	Tubulanus (LPIL)	2
Station 2	Annelida	Polychaeta	Phyllodocida	Goniadidae	Goniada littorea	1
Station 2	Annelida	Polychaeta	Phyllodocida	Nephtyidae	Nephtyidae (LPIL)	3
Station 2	Annelida	Polychaeta	Phyllodocida	Phyllodocidae	Phyllodoce arenae	1
Station 2	Annelida	Polychaeta	Spionida	Spionidae	Scolelepis texana	34
Station 2	Annelida	Polychaeta	Spionida	Spionidae	Dipolydora socialis	1
Station 2	Mollusca	Bivalvia			Bivalvia (LPIL)	1
Station 2	Mollusca	Bivalvia	Arcoida	Arcidae	Arcidae (LPIL)	1
Station 2	Arthropoda	Malacostraca	Amphipoda	Bateidae	Batea catharinensis	1
Station 2	Arthropoda	Malacostraca	Amphipoda	Haustoriidae	Protohaustorius sp. C	7
Station 2	Arthropoda	Malacostraca	Amphipoda	Phoxocephalidae	Rhepoxynius epistomus	2
Station 2	Arthropoda	Malacostraca	Cumacea	Diastylidae	Oxyurostylis smithi	1
Station 2	Arthropoda	Malacostraca	Decapoda	Pinnotheridae	Dissodactylus mellitae	1
Station 2	Echinodermata	Echinoidea	Clypeasteroida	Mellitidae	Mellita quinquiesperforata	1
Station 3	Nemertea				Nemertea (LPIL)	3
Station 3	Annelida	Polychaeta	Phyllodocida	Glyceridae	Glyceridae (LPIL)	1
Station 3	Annelida	Polychaeta	Spionida	Magelonidae	Magelona papillicornis	1
Station 3	Annelida	Polychaeta	Spionida	Spionidae	Apoprionospio pygmaea	1
Station 3	Annelida	Polychaeta	Spionida	Spionidae	Spiophanes bombyx	3
Station 3	Annelida	Polychaeta	Spionida	Spionidae	Scolelepis texana	19
Station 3	Mollusca	Gastropoda	Neogastropoda	Nassariidae	Nassarius acutus	1
Station 3	Mollusca	Gastropoda	Neogastropoda	Olividae	Olivella dealbata	1
Station 3	Mollusca	Gastropoda	Neogastropoda	Terebridae	Terebra dislocata	1
Station 3	Arthropoda	Malacostraca	Amphipoda	Haustoriidae	Protohaustorius sp. C	1
Station 3	Arthropoda	Malacostraca	Amphipoda	Phoxocephalidae	Rhepoxynius epistomus	1
Station 3	Arthropoda	Malacostraca	Cumacea	Diastylidae	Oxyurostylis smithi	6
Station 3	Arthropoda	Malacostraca	Decapoda	Paguridae	Pagurus (LPIL)	5
Station 4	Nemertea				Nemertea (LPIL)	2
Station 4	Annelida	Polychaeta	Capitellida	Capitellidae	Mediomastus (LPIL)	1
Station 4	Annelida	Polychaeta	Oweniida	Oweniidae	Owenia fusiformis	1
Station 4	Annelida	Polychaeta	Phyllodocida	Glyceridae	Glyceridae (LPIL)	2
Station 4	Annelida	Polychaeta	Phyllodocida	Nephtyidae	Nephtyidae (LPIL)	1
Station 4	Annelida	Polychaeta	Spionida	Spionidae	Apoprionospio pygmaea	21
Station 4	Annelida	Polychaeta	Spionida	Spionidae	Spiophanes bombyx	6
Station 4	Annelida	Polychaeta	Spionida	Spionidae	Scolelepis texana	5
Station 4	Annelida	Polychaeta	Terebellida	Sabellariidae	Sabellaria vulgaris	1
Station 4	Mollusca	Bivalvia	Veneroida	Lucinidae	Lucinidae (LPIL)	1
Station 4	Arthropoda	Malacostraca	Amphipoda	Haustoriidae	Protohaustorius sp. C	3
Station 4	Arthropoda	Malacostraca	Amphipoda	Oedicerotidae	Americhelidium americanum	1
Station 4	Arthropoda	Malacostraca	Amphipoda	Phoxocephalidae	Rhepoxynius epistomus	2
Station 4	Arthropoda	Malacostraca	Amphipoda	Platyischnopidae	Eudevenopus honduranus	2
Station 4	Arthropoda	Malacostraca	Amphipoda	Synopiidae	Metatiron tropakis	1
Station 4	Arthropoda	Malacostraca	Cumacea	Diastylidae	Oxyurostylis smithi	11
Station 4	Arthropoda	Malacostraca	Mysidacea	Mysidae	Promysis atlantica	1
Station 4	Phoronida			Phoronidae	Phoronis (LPIL)	3
Station 5	Nemertea				Nemertea (LPIL)	3
Station 5	Rhynchocoela	Anopla	Paleonemertea	Tubulanidae	Tubulanus (LPIL)	2
Station 5	Annelida	Polychaeta	Capitellida	Capitellidae	Mediomastus (LPIL)	3

Station ID	Phylum	Class	Order	Family	Taxon Name	No. Individuals
Station 5	Annelida	Polychaeta	Eunicida	Onuphidae	Onuphidae (LPIL)	1
Station 5	Annelida	Polychaeta	Phyllodocida	Glyceridae	Glyceridae (LPIL)	1
Station 5	Annelida	Polychaeta	Phyllodocida	Goniadidae	Goniada littorea	1
Station 5	Annelida	Polychaeta	Phyllodocida	Nephtyidae	Nephtyidae (LPIL)	4
Station 5	Annelida	Polychaeta	Phyllodocida	Pilargiidae	Sigambra tentaculata	1
Station 5	Annelida	Polychaeta	Spionida	Magelonidae	Magelona pettiboneae	1
Station 5	Annelida	Polychaeta	Spionida	Magelonidae	Magelona sp. H	1
Station 5	Annelida	Polychaeta	Spionida	Spionidae	Apoprionospio pygmaea	21
Station 5	Annelida	Polychaeta	Spionida	Spionidae	Spiophanes bombyx	5
Station 5	Annelida	Polychaeta	Spionida	Spionidae	Scolelepis texana	2
Station 5	Annelida	Polychaeta	Terebellida	Sabellariidae	Sabellaria vulgaris	2
Station 5	Mollusca	Bivalvia	Veneroida	Tellinidae	Tellina (LPIL)	1
Station 5	Arthropoda	Malacostraca	Amphipoda	Oedicerotidae	Americhelidium americanum	1
Station 5	Arthropoda	Malacostraca	Amphipoda	Phoxocephalidae	Rhepoxynius epistomus	2
Station 5	Arthropoda	Malacostraca	Amphipoda	Synopiidae	Metatiron tropakis	1
Station 5	Arthropoda	Malacostraca	Cumacea	Diastylidae	Oxyurostylis smithi	4
Station 5	Arthropoda	Malacostraca	Decapoda	Pasiphaeidae	Leptochela serratorbita	1
Station 5	Arthropoda	Malacostraca	Mysidacea	Mysidae	Promysis atlantica	2
Station 5	Phoronida			Phoronidae	Phoronis (LPIL)	13
Station 6	Nemertea				Nemertea (LPIL)	1
Station 6	Rhynchocoela	Anopla	Paleonemertea	Tubulanidae	Tubulanus (LPIL)	1
Station 6	Annelida	Polychaeta	Capitellida	Capitellidae	Mediomastus ambiseta	18
Station 6	Annelida	Polychaeta	Capitellida	Capitellidae	Mediomastus (LPIL)	4
Station 6	Annelida	Polychaeta	Phyllodocida	Goniadidae	Glycinde solitaria	1
Station 6	Annelida	Polychaeta	Phyllodocida	Goniadidae	Goniada littorea	1
Station 6	Annelida	Polychaeta	Phyllodocida	Nephtyidae	Nephtyidae (LPIL)	4
Station 6	Annelida	Polychaeta	Phyllodocida	Pilargiidae	Sigambra tentaculata	2
Station 6	Annelida	Polychaeta	Spionida	Cirratulidae	Cirratulidae (LPIL)	2
Station 6	Annelida	Polychaeta	Spionida	Cirratulidae	Tharyx acutus	3
Station 6	Annelida	Polychaeta	Spionida	Magelonidae	Magelona pettiboneae	2
Station 6	Annelida	Polychaeta	Spionida	Magelonidae	Magelona sp. H	5
Station 6	Annelida	Polychaeta	Spionida	Spionidae	Paraprionospio pinnata	3
Station 6	Annelida	Polychaeta	Spionida	Spionidae	Spiophanes bombyx	5
Station 6	Annelida	Polychaeta	Spionida	Spionidae	Streblospio benedicti	1
Station 6	Annelida	Polychaeta	Spionida	Spionidae	Scolelepis (LPIL)	3
Station 6	Annelida	Polychaeta	Spionida	Spionidae	Dipolydora socialis	1
Station 6	Mollusca	Gastropoda	Mesogastropoda	Naticidae	Tectonatica pusilla	7
Station 6	Arthropoda	Malacostraca	Cumacea	Diastylidae	Oxyurostylis smithi	1
Station 6	Arthropoda	Malacostraca	Mysidacea	Mysidae	Promysis atlantica	1
						342

Table 3. Taxonomic species list.

ANNELIDA
- CLASS POLYCHAETA
  - Order CAPITELLIDA
    - FAMILY CAPITELLIDAE
      - Mediomastus (LPIL)
      - Mediomastus ambiseta
  - Order EUNICIDA
    - FAMILY ONUPHIDAE
      - Onuphidae (LPIL)
  - Order OWENIIDA
    - FAMILY OWENIIDAE
      - Owenia fusiformis
  - Order PHYLLODOCIDA
    - FAMILY GLYCERIDAE
      - Glyceridae (LPIL)
    - FAMILY GONIADIDAE
      - Glycinde solitaria
      - Goniada littorea
    - FAMILY NEPHTYIDAE
      - Nephtyidae (LPIL)
    - FAMILY PHYLLODOCIDAE
      - Phyllodoce arenae
    - FAMILY PILARGIIDAE
      - Sigambra tentaculata
  - Order SPIONIDA
    - FAMILY CIRRATULIDAE
      - Cirratulidae (LPIL)
      - Tharyx acutus
    - FAMILY MAGELONIDAE
      - Magelona papillicornis
      - Magelona pettiboneae
      - Magelona sp. H
    - FAMILY SPIONIDAE
      - Apoprionospio pygmaea
      - Dipolydora socialis
      - Paraprionospio pinnata
      - Polydora cornuta
      - Scolelepis (LPIL)
      - Scolelepis texana
      - Spiophanes bombyx
      - Streblospio benedicti
  - Order TEREBELLIDA
    - FAMILY AMPHARETIDAE
      - Hobsonia florida
    - FAMILY SABELLARIIDAE
      - Sabellaria vulgaris

ARTHROPODA
- CLASS MALACOSTRACA
  - Order AMPHIPODA
    - FAMILY BATEIDAE

Batea catharinensis
FAMILY HAUSTORIIDAE
Protohaustorius sp. C
FAMILY OEDICEROTIDAE
Americhelidium americanum
FAMILY PHOXOCEPHALIDAE
Rhepoxynius epistomus
FAMILY PLATYISCHNOPIDAE
Eudevenopus honduranus
FAMILY SYNOPIIDAE
Metatiron tropakis
Order CUMACEA
FAMILY DIASTYLIDAE
Oxyurostylis smithi
Order DECAPODA
FAMILY PAGURIDAE
Pagurus (LPIL)
FAMILY PASIPHAEIDAE
Leptochela serratorbita
FAMILY PINNOTHERIDAE
Dissodactylus mellitae
Order MYSIDACEA
FAMILY MYSIDAE
Promysis atlantica

ECHINODERMATA
CLASS ECHINOIDEA
Order CLYPEASTEROIDA
FAMILY MELLITIDAE
Mellita quinquiesperforata

MOLLUSCA
CLASS BIVALVIA
Bivalvia (LPIL)
Order ARCOIDA
FAMILY ARCIDAE
Arcidae (LPIL)
Order VENEROIDA
FAMILY LUCINIDAE
Lucinidae (LPIL)
FAMILY MACTRIDAE
Mulinia lateralis
FAMILY TELLINIDAE
Tellina (LPIL)

CLASS GASTROPODA
Order MESOGASTROPODA
FAMILY NATICIDAE
Tectonatica pusilla

Order NEOGASTROPODA
FAMILY NASSARIIDAE
Nassarius acutus
FAMILY OLIVIDAE
Olivella dealbata
FAMILY TEREBRIDAE
Terebra dislocata

NEMERTEA
Nemertea (LPIL)

PHORONIDA
FAMILY PHORONIDAE
Phoronis (LPIL)

RHYNCHOCOELA
CLASS ANOPLA
Order PALEONEMERTEA
FAMILY TUBULANIDAE
Tubulanus (LPIL)